# Diagnostics Plans

# Outline


- Interface and Integration
- The Goal and the Obstacles
- System Plans by Priority
- ‘Diagnostic Event’ Triggers and Buffering
- Unified Data Display

# Interface and Integration


- Diagnostics are maturing
  - Major systems are in place and shaken out
  - Effort shifting to Interface and Integration
- Interface to Operations
  - Unified Data Displays - Injection, Ramp, Store
  - Minimize need for Documentation and Specialists
- Integration During L/P$^2$ and Machine Development
  - Instruments run from the Sequencer, or
  - Instruments integrated with Applications where possible, or
  - Instruments operable from MCR w/o specialists

# The Goal and the Obstacles


- How we (Diagnostics) understand our job
- Goal - to assist in providing L and $P^2$
- Obstacles - limits are defined by
  - Control of Tune, Chromaticity, and Coupling
  - Injection Efficiency - matching, damping, IBS, e-cloud/vacuum, beam-beam, dynamic aperture,...
  - Ramp Reliability - IBS, e-cloud/vacuum, beam-beam, instabilities, transition, ...
  - $L/P^2$ Lifetime at Store - IBS, beam-beam, e-cloud/vacuum, dynamic aperture, resonance compensation, nonlinearities,…
  - Short lifetime requires good injection efficiency and ramp reliability

# System Plans by Priority


- BLM - recalibrate thresholds
- BPM - Todd separate talk this session
- WCM/DCCT - no major changes, FFT (split?)
- ARTUS - in this talk
- PLL - separate talk this session
- IPM - Roger separate talk this session; nestled IPM and the optical IPM
- Schottky's - in this talk
- AC Dipole - in this talk
- Dampers - Angelika and Mike separate talks this session
- Coherence Monitor - Mike separate talk this session
- Head-Tail, Buttons, QMM - in this talk
- Stochastic Cooling - good data from last run. Plan?

# ARTUS


- Version 2 Analog Front End
  - Easier and more reliable timing
  - Enables another coherence monitor?
  - Enables switch to all large β BPMs
- All large β BPMs
  - Helps compensate for loss of 2m of Kicker to Damper
  - Requires additional hardware and effort from Controls
- Preamps in the tunnel?

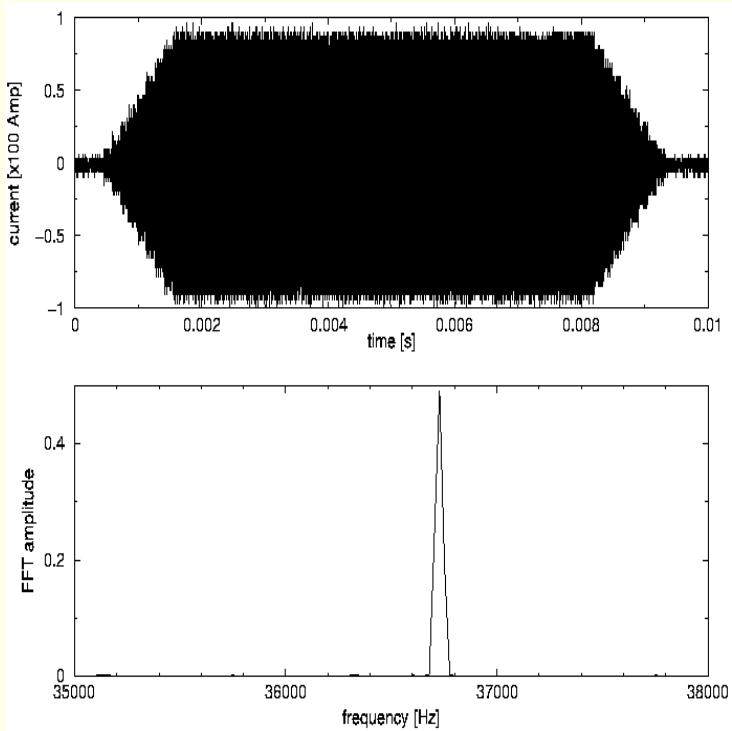
# LF and HF Schottky


- Summary of Last Run - Schottky did not fulfill its potential
  - Saturation - due beam steering and effect of 200MHz RF
  - Frequency agility - available local oscillators, mixers, digitizers
  - Software (version control and LabVIEW idiosyncrasies)
  - GBytes of HF spectra archived - will be examined with refined software
- Plans for next run
  - Solve aperture problems around IP2 (also important for IPM)
  - Position control of Moveable BPM
  - Improved frequency agility - NCOs, independent B & Y, cavity resonance tracking,…
  - Complete the move from DSAs - poor data access, network storms, free for studies,...
  - LF and HF data acquisition and software to be almost identical
  - Data flow for both systems same as HF Schottky in last run - proven, reliable,...
  - Data will be available continuously for 6 ch of HF and 4 ch of LF Schottky/PLL

# Mei Bai - Applications of RHIC AC Dipole(s)


- spin manipulation
  - spin flipping √
  - measure spin precession tune
- excite long-lasting coherent oscillation for
  - linear optics measurement √
  - linear coupling measurement √
  - non-linear resonance measurement
- specs

| Application | BmL [Gm] | Field Orientation | Center frequency [kHz] | Tunnin range [kHz] | Duty time |
|---|---|---|---|---|---|
| Spin flipping | ≥100 | Hori | 37.5 | ±1.0 | 2.4s |
| Linear optics Measurement | 78 | Vert Hori | 64.0 | _ | 40ms |
| Non-linearity Measurement | 380 | Vert hori | 64.0 | ±1.0 | ≥80ms |

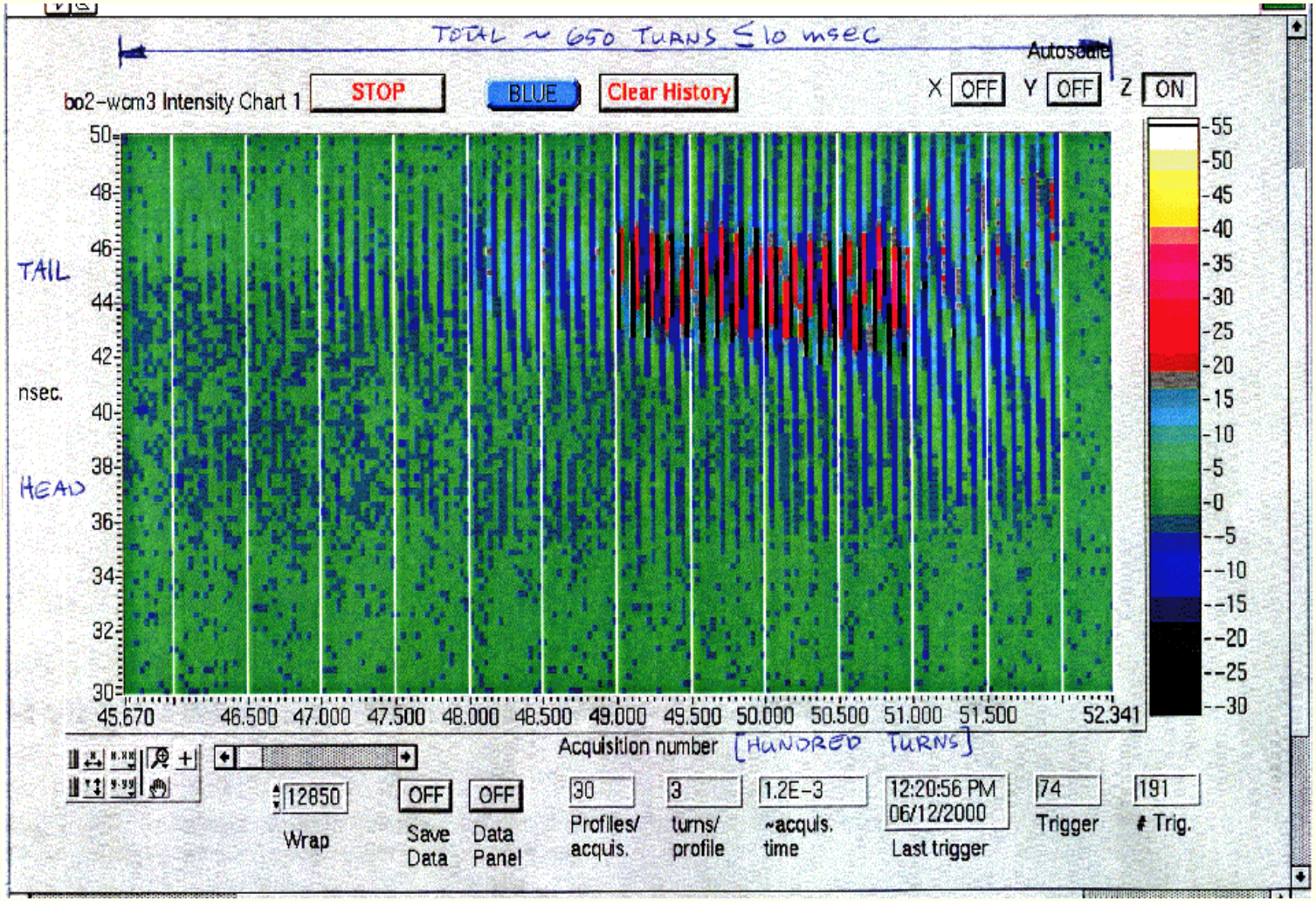



The current readback of RHIC vertical ac dipole and its spectrum. The ac dipole was configured to resonate at 36.6 kHz for the spin flipping.

# Head-Tail, Button, and QMM


- DAQ parallels present WCM system - dedicated fast scopes with deep memory, triggers from V124 or ?, local processing to spare the network
- Head-Tail
  - Use existing 1m striplines? Install additional?
  - Useful for Instabilities, Chromaticity parasitic to ARTUS,…
  - Multiband transverse spectra
- Buttons - Broadband transverse spectra
- Quadrupole Moment Monitor
  - Difference of sum modes from resonant moveable/PLL BPM? New PU?
  - Resonant pickup above coherent spectrum gives needed sensitivity?
  - Injection Matching, Studies (quadrupole kicker), Schottky spectra,...

# Example of Head-Tail



# Triggers and Buffering


- Want fast 'diagnostics event' trigger (generally on the ramp)
- Possible triggers
  - Time domain
    - BLMs, Coherence monitor(s), Head-Tail, Buttons,…
    - Emittance growth - IPM, Schottkys,...
  - Frequency Domain - Longitudinal
    - WCM - broadband
    - LF and HF Schottky - 'receiver' at revolution line; narrowband
  - Frequency Domain - Transverse (Beam Transfer Functions!)
    - Buttons - broadband
    - Head - Tail - multiband
    - Schottkys - narrowband
- For fast events necessary to buffer - a few seconds (at worst) is practical
- What to buffer? - WCM, buttons, head-tail, QMM?, Schottky's

# Unified Data Display


- Three monitors (ie CRTs) - two frequency domain, one time domain
- Zoomable windows
- Frequency domain - broadband and narrowband
  - Broadband - WCM, Buttons, Head-tail…
  - Narrowband - Artus, Schottky (10 ch?),…
  - Format - spectrogram plus most recent in conventional line presentation
- Time Domain - Tune/Chrom/Coupling and Others
  - Tune/Chrom/Coupling - BPMs, ARTUS, PLL, Schottkys,...
  - Others - emittance, coherence, WCM/DCCT, RF BPMs, QMM, BLM?,...
- Three Conditions (with auto-switching) - Injection, Ramp, Store
- Data management issues - update rates, replication, display speed,...
- Recoverable from archive in this format - unzoom time scale?